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EFFECTS OF STORAGE TEMPERATURES
ON
QUALITY OF SOYBEAN SALAD OIL

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PREFACE

The study on which this report is based is part of a comprehensive research project on evaluating quality and developing objective measures of quality characteristics to improve efficiency in marketing agricultural products.

This report is part of a study for the determination of the effects of storage temperatures on keeping quality of cottonseed and soybean salad oils in sealed 1-gallon containers.

Marketing Research Report No. 861, entitled "Effects of Storage Temperatures on Quality of Cottonseed Salad Oil," is another report on this work.

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EFFECTS OF STORAGE TEMPERATURES ON QUALITY OF SOYBEAN SALAD OIL

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SUMMARY AND CONCLUSIONS

Three different lots of soybean salad oils, packaged in sealed 1-gallon metal containers, were stored for periods of up to 2 years at specific temperatures ranging from 55° to 110° F.

A taste panel of housewives evaluated the oils by comparing them with similar oils that had been held frozen at 0° F. during the 2-year period.

The differences in flavor scores between the oils from heated storage and the refrigerated oils showed that in oils held at 55°, 70°, and 80° F., changes were negligible during the 2 years. The oils held at 90° F. for 2 years showed some decrease in flavor which was not considered significant. However, the oils stored at 100° and 110° F. showed definite decreases in flavor before the end of the first year of storage.

The oils that had been removed from both the heated and the refrigerated storage were exposed to air during 4 days of treatment at 140° F., then a second evaluation of flavor was made.

The decrease in flavor scores after the 4-day heat treatment of the oils held at 55°, 70°, 80°, and 90° F. for 2 years was somewhat less than that of the oils before the heat treatment. When oils that had been stored at 100° F. for periods of less than 1 year received the 4-day heat treatment, the flavor score did not decrease below the score of the same oils without the heat treatment. The oils that had been stored at 110° F. showed improved flavor scores when they received the heat treatment.

The flavor adjectives used by the panel before and after the 4-day heat treatment of the stored oils showed minor changes, but there appeared to be little relationship between the changes in flavor scores and the flavor adjectives used.

INTRODUCTION

Vegetable salad oils packaged in sealed 1-gallon metal cans containing cottonseed or soybean oil are generally used domestically within a short time after manufacture. However, when purchased by the Commodity Credit Corporation, these oils may be held in storage for several months before shipment overseas. To insure maintenance of quality, the Government agency may use refrigerated storage. Normally these oils are held at room temperatures before purchase domestically or by the Government.

Industry sources have estimated that salad oils made from cottonseed or soybeans and containing no synthetic antioxidants should change very little in quality for periods up to a year or more if held under reasonable temperatures.

However, salad oils purchased by the Government may be subjected to much higher temperatures during shipment and in foreign ports.

No previous data were available comparing cottonseed or soybean salad oils stored in sealed containers for periods of time under controlled temperatures with similar oils in refrigerated storage.

OBJECTIVES

The primary objectives of this study were to compare the flavor of soybean salad oils in sealed containers after dry storage and after refrigerated storage, and then, after a heat treatment with the cans open, to compare the flavor of the same oils again.

Other objectives were:

(1) To determine the storage temperatures and time required to develop a difference in flavor that could be noticed by the average consumer either at the end of the storage period or after the heat treatment during which the cans were open.

(2) To determine any relationships between the quality of the oils before and after storage; and after the further heat treatment.

(3) To ascertain the relationship between flavor scores and flavor adjectives as used by the taste panel.

METHODS

Procurement and Storage of Oil

Among the vendors who have been approved by the United States Government, 10 have sold soybean salad oil for export packaged in 1-gallon metal containers during recent years. These vendors have complied with Federal specifications.[1] Three of these vendors made salad oils available for this study, one from the east coast, one from the west coast, and one from the southern area of the country. From each source, 36 one-gallon containers of oil were obtained. Each lot of oil (hereinafter designated as Source 1, Source 2, or Source 3) was probably canned from the same batch of oil at the refinery, which meant that it had the same source of soybeans and went through the processing stages of extraction, refining, and deodorization of the oil at the same time.

Each lot was divided so that 12 cans were put into storage at 0° F. and held frozen as controls for comparison with the same oils stored at the higher temperatures. The other 24 cans were put into constant-temperature cabinets, four cans each at 55°, 70°, 80°, 90°, 100°, and 110° F. until ready for taste panel tests. Cans held at 0° F. (controls) were removed from refrigeration as needed for panel evaluations.

Flavor Evaluation

The flavor panel or taste panel, hereinafter called the "panel," followed the general procedures[2] used at the Northern Utilization Research and Development Division, ARS, at Peoria, Ill., except for the qualifications of the panelists conducting the evaluations. The Peoria laboratory panel is made up of personnel who have been highly trained in the evaluation of salad oils, and the scores given to the oils by the individual panelists and the average for all the panelists would show less variation than would be expected from the panel used in this study.

The preliminary training of those chosen for this panel, mostly housewives, did not require that they be experts in distinguishing small differences between the oils. However, they were expected to be able to distinguish large differences in flavor between oils prepared especially for choosing panelists. Most of those used in the panel did have some previous experience in evaluating quality differences in and preferences for frozen fruits, vegetables, juices, sauces, etc., but not in evaluating salad oils.

At the end of each 6-month period, cans of the oils, after being removed from storage and cooled to 0° F., were sent to the panel for evaluation along with the control cans which had been held at 0° F. All of the oils were warmed to 98° F. immediately before the evaluations, and were refrozen at 0° F., after samples had been taken for the day's evaluations.

The oils were coded before presentation to the panel to distinguish the source number, the control for each source, and cans that were stored at higher temperatures. The code did not disclose the temperature of storage. The panel supervisor filled in separate reports for the codes used in the particular series evaluated. The panel members did not know which one of the samples was the control, nor did they know they were evaluating the same oils under the same conditions several times when these oils were compared with the six oils stored at different temperatures. The oils from one source were not compared with oils from the other two sources, either as controls or at higher storage temperatures. No definitions of the descriptive adjectives used on the report forms were given to the panelists before or during the evaluations.

There were 20 panelists on each day. Three "sittings" were made at half-hour intervals. At each sitting of the panel in the 6- and 12-month evaluations, four samples were tasted, one of which was the control and three of which were high-temperature-stored oils from the same source (report 1, appendix). Judging the six sample oils from each source required three sittings on each of 2 days.

For the 18-month storage period, only oils stored at 55°, 70°, and 80° F. were evaluated. The three samples were compared with the same control at the same tasting, requiring only one sitting of the panel for the oils from each of the three sources.

In each sitting, at the end of 24 months, two of the oils stored at 55°, 70°, 80°, and 90° F. were compared with the control. This required two sittings of the panel for each of the three sources (report 3).

Post-Storage Heat Treatment

In previous taste panel work by Moser and coworkers, it had been found that heating both the controls and the oils to be evaluated accentuated the flavor.[2] This treatment may also remove some volatiles formed during the storage period. Therefore, after the first evaluation in this study, all samples of these oils were heated for 4 days at 140° F. (60° C.) in glass containers loosely stoppered with Pyrex wool.[3] After this 4-day heat treatment, all samples were submitted to the taste panel again.

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[1] Federal Specifications for Salad Oil as approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal agencies. JJJ–S–30 (with Amendment 2) May 4, 1964.

[2] MOSER, HELEN A., H. J. DUTTON, C. D. EVANS, and J. C. COWAN. CONDUCTING A TASTE PANEL FOR THE EVALUATION OF EDIBLE OILS. Food Technol. 4: 105–109. 1950.

[3] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

At the end of the 6- and 12-month storage periods, each of the high-temperature-stored oils that had received a 4-day heat treatment was compared with the control separately. Three evaluations were recorded on report 2 (appendix) for each of 2 days' sittings for each of the three sources. After the 18-month storage period, only the oils stored at 55°, 70°, and 80° F. were evaluated with the 4-day heat treatment. The three samples from each source were compared with the control at one sitting.

At the end of the 24-month period, two of the oils stored at 55°, 70°, 80°, and 90° F. were compared with the control, using report 4 (appendix). Results from these evaluations of the oils after the 4-day heat treatment were recorded as differences in flavor scores, as with the previous evaluations.

FLAVOR SCORES IMMEDIATELY AFTER STORAGE

Variation in Scoring

It was expected that there would be rather large variations in the flavor scores for each of the evaluations by the panel, not only between individual panelists for the same oil at the same sitting and on the same day, but by the same panelists at different sittings as well. This can be shown by measuring the variations of the flavor scores for the oils held frozen at 0° F. (the controls). There is no reason to expect any changes in the flavor of the samples of oil held far below its freezing point. Accordingly, the best estimate of the flavor score would be an average of the many scores given to each of the control oils from the three sources. These data are shown in table 1.

No relationship is shown between the average score and the length of time the control sample was in storage; the flavor score did not change during storage of the oils at 0° F.

There was a highly significant relationship, however, between the average flavor score and the standard deviation. As the average flavor score decreased, the variation, as measured by the standard deviation, increased.[4] As an example, when the formula is used for a flavor score of 9.15, the standard deviation would be ±0.9745 and for a flavor score of 6.95, the standard deviation would be ±1.9070. Accordingly, using average flavor scores for each sitting of the panel of 20 panelists, for the control and the oil in heated storage from 55° F. to 110° F., the change of flavor with time of storage could not be determined with any degree of accuracy.

A better estimate of change in flavor could be made by determining the difference between flavor scores of the control oil and of the heated stored oil at each evaluation, than by using average flavor scores for the control and the heated stored oil for the 20 panelists at each sitting. Each comparison of the control sample with the heated stored oil constituted a single observation. For oil from each source at a different storage temperature, there were 20 different individual comparisons with the control. Four different storage periods gave 80 observations on each of the oils at each temperature. These data were used in linear correlations as follows.

Changes After Storage

Figures 1, 2, and 3 show the linear correlations for these differences in flavor scores of the oil from

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[4] The formula for all the three sources of the oil is: Y = 4.8530 −0.4239X, where X = the flavor score and Y = the standard deviation. Also, r = −0.7672, N = 21, and S_{YX} = ±0.1978.

TABLE 1.—*Variation in flavor scores of soybean salad oils stored at 0° F.*

[Each average and standard deviation was calculated from the flavor scores of the 20 panelists at one sitting of the panel.]

Months in storage	Source 1		Source 2		Source 3	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
6	8.25	±1.0699	9.10	±0.9119	8.85	±1.2680
6	8.20	±1.4364	8.30	±1.4546	8.35	±1.1367
12	7.90	±1.8610	6.95	±1.9324	8.85	±1.1821
12	8.50	±1.5390	8.95	±1.1910	8.30	±1.2183
18	8.55	±1.1910	8.25	±1.2513	7.80	±1.3219
24	8.90	±1.1653	8.90	±0.9679	9.15	±0.7450
24	9.05	±0.8256	9.15	±1.3870	9.15	±0.8127
Total	8.48	±1.3596	8.51	±1.4936	8.64	±1.1887

each source at each of the six temperatures of storage. The formulas for the regression lines are shown in table 2.

In the evaluations of the oils held at 100° and 110° F. for up to 9 months, there was a definite decrease in flavor score. It was determined at this time that any further storage of the oils at these temperatures would be accompanied by such low flavor scores that the results would be too variable for statistical validity.

Continued storage of the oils at the four lower temperatures, even after 2 years, did not show decreases in flavor scores that could be termed important. This was particularly true when the variation as measured by the standard error of estimate was considered (table 2).

Data from the oil from three sources stored at each of the six different temperatures showed no statistically significant difference in the rate of change in the differences between the flavor scores of the control and heat-stored oils. Accordingly, these data were grouped to give the correlation results shown under "all sources" in table 2, and these results were shown graphically in figure 4.

The three soybean oils stored at temperatures of 55°, 70°, and 80° F. showed a negligible decline in flavor score at the end of 2 years, and the oils stored at 90° F. showed a decrease in flavor after 2 years which could not be called important as judged by the panel. The oils held at 100° and 110° F. showed a marked decrease in flavor before the end of the first year of storage.

Table 2.—*Correlation data for differences of flavor scores of three soybean salad oils after storage at six temperatures from flavor scores of the same oils after storage at 0° F.*

Storage temperature and oil source	Formula	N [1]	r [2]	S_{Y_X} [3]
Oil stored at 55° F.:				
Source 1	Y=+0.6125−0.04994X	80	−0.1881	±1.7426
Source 2	Y=−0.8000+0.0650X	80	+0.2499	±1.7001
Source 3	Y=+0.0333−0.0356X	80	−0.1465	±1.6065
All sources	Y=+0.0881−0.0159X	240	−0.0616	±1.7355
Oil stored at 70° F.:				
Source 1	Y=+0.3250−0.0633X	80	−0.2041	±2.0510
Source 2	Y=+0.9500−0.0608X	80	−0.2126	±1.8879
Source 3	Y=−0.4750−0.0625X	80	−0.2328	±1.7622
All sources	Y=+0.2667−0.0622X	240	−0.2059	±1.9869
Oil stored at 80° F.:				
Source 1	Y=+0.6000−0.1017X	80	−0.3648	±1.7515
Source 2	Y=−0.5750+0.0100X	80	−0.0332	±2.0351
Source 3	Y=+0.5250−0.0525X	80	−0.2109	±1.6430
All sources	Y=−0.1667−0.0481X	240	−0.1701	±1.8714
Oil stored at 90° F.:				
Source 1	Y=−0.7667−0.4345X	60	−0.1494	±2.1728
Source 2	Y=+0.4750−0.1339X	60	−0.3960	±2.0256
Source 3	Y=+1.0000−0.0738X	60	−0.2664	±2.0321
All sources	Y=−0.4333−0.0837X	180	−0.2738	±2.2076
Oil stored at 100° F.:				
Source 1	Y=+0.5500−0.2333X	40	−0.1748	±1.9968
Source 2	Y=−2.4500+0.1167X	40	−0.0798	±2.1277
Source 3	Y=−0.1000−0.2667X	40	−0.1614	±2.4766
All sources	Y=−0.2333−0.1833X	120	−0.1223	±2.2408
Oil stored at 110° F.:				
Source 1	Y=+1.6667−0.6833X	40	−0.3831	±2.5164
Source 2	Y=+3.8833−0.9667X	40	−0.5688	±2.1231
Source 3	Y=−2.6750−0.0667X	40	−0.0376	±2.6898
All sources	Y=+0.9444−0.5722X	120	−0.3242	±2.5147

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[1] Number of observations. Oils stored at 55°, 70°, and 80° F. were evaluated after 6, 12, 18, and 24 months. Oils stored at 90° F. were evaluated after 6, 12, and 24 months. Oils stored at 100° F. were evaluated after 6 and 9 months. Oils stored at 110° F. were evaluated after 5 and 8 months.

[2] Correlation coefficient. At the 5-percent confidence limit, $r=0.312$ when $N=40$; $r=0.254$ when $N=60$; $r=0.220$ when $N=80$; and $r=0.170$ when $N=120$. At the 1-percent confidence limit, $r=0.404$ when $N=40$; $r=0.302$ when $N=60$; $r=0.286$ when $N=80$; and $r=0.226$ when $N=120$.

[3] Standard error of estimate.

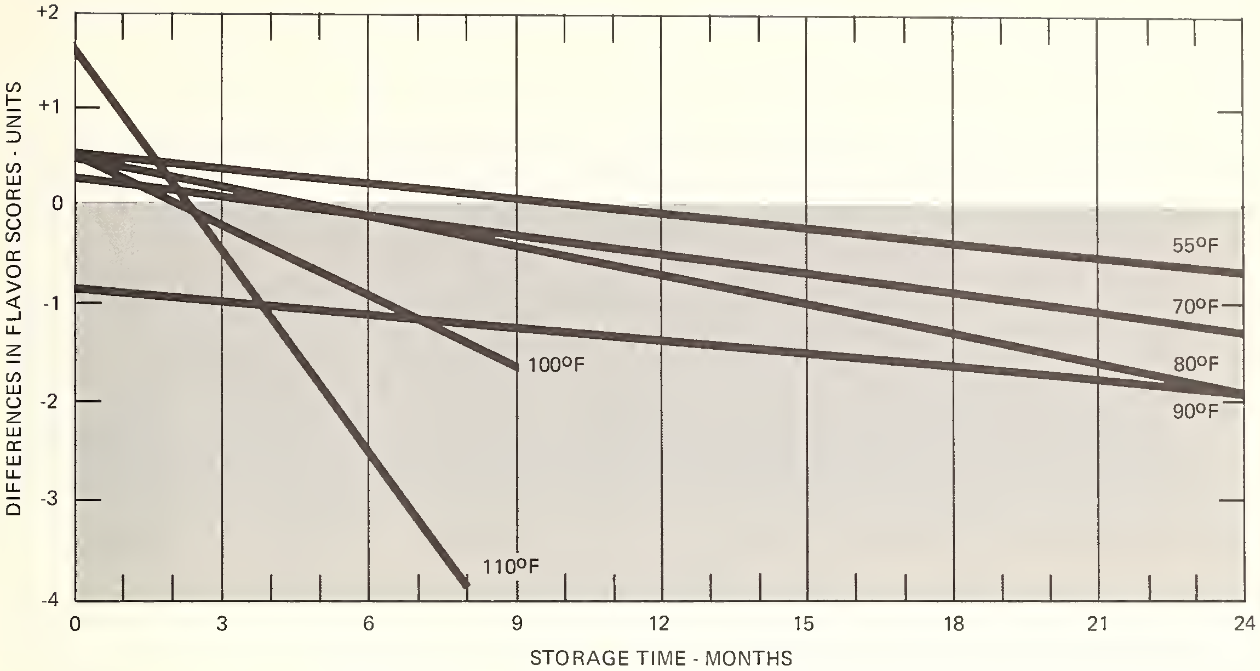

FIGURE 1.—Soybean salad oil from source 1: Difference in flavor scores between oil stored at six temperatures and oil stored at 0° F.

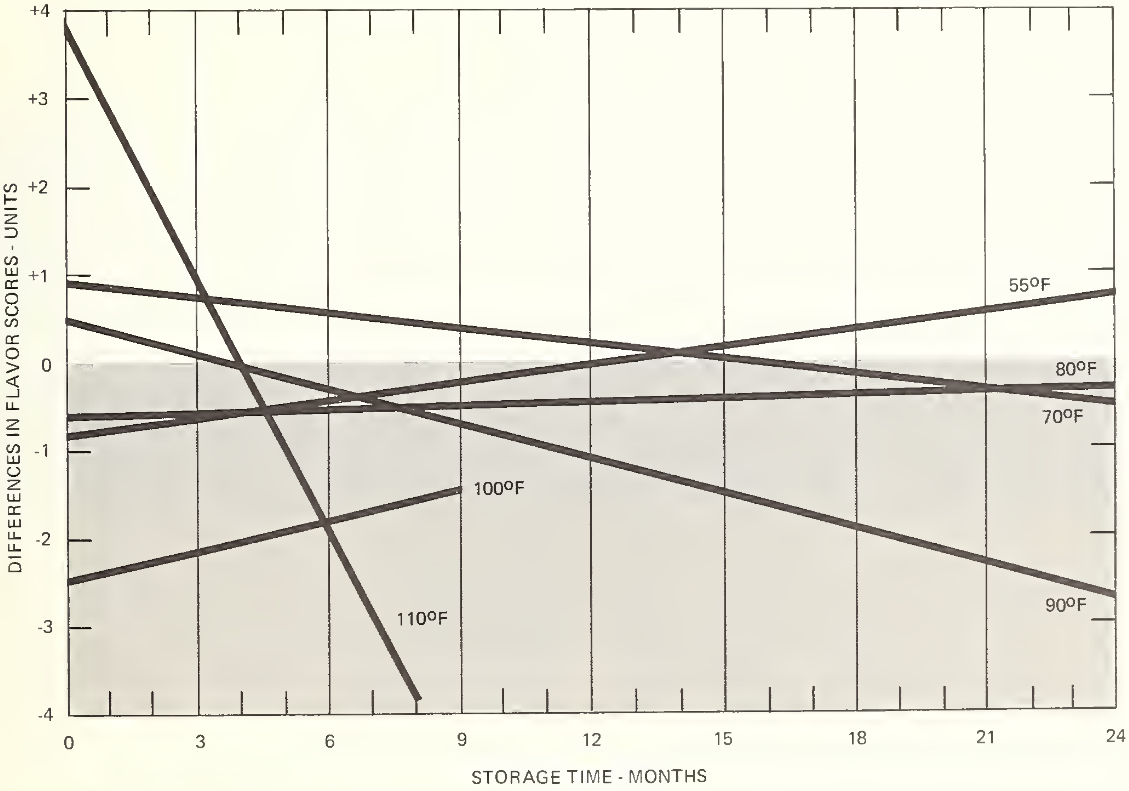

FIGURE 2.—Soybean salad oil from source 2: Differences in flavor scores between oil stored at six temperatures and oil stored at 0° F.

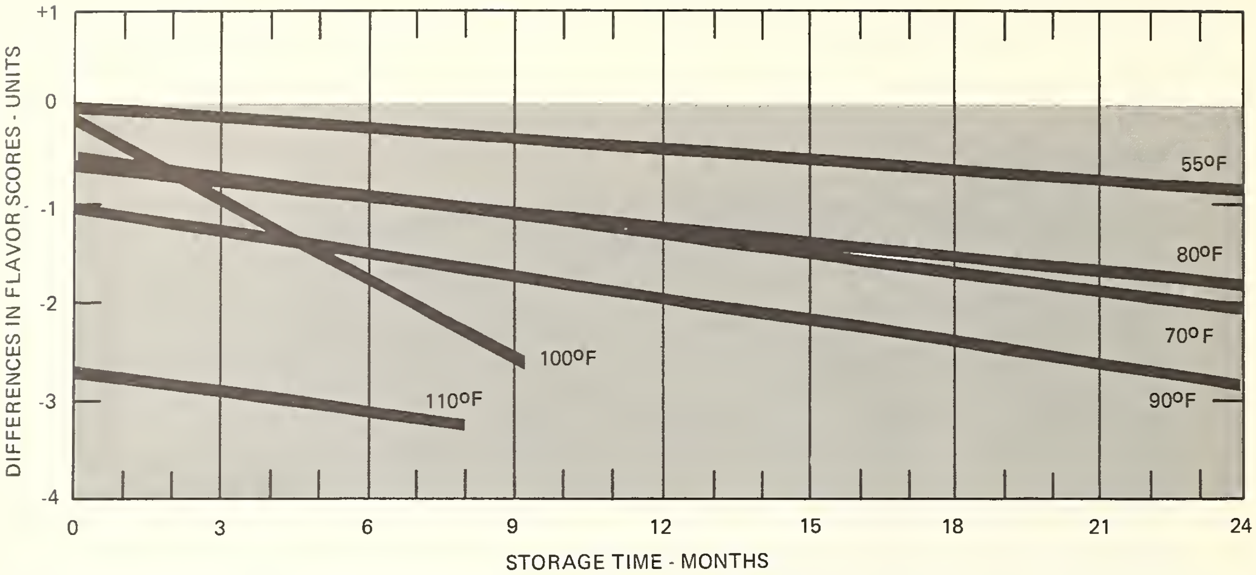

FIGURE 3.—Soybean salad oil from source 3: Differences in flavor scores between oil stored at six temperatures and oil stored at 0° F.

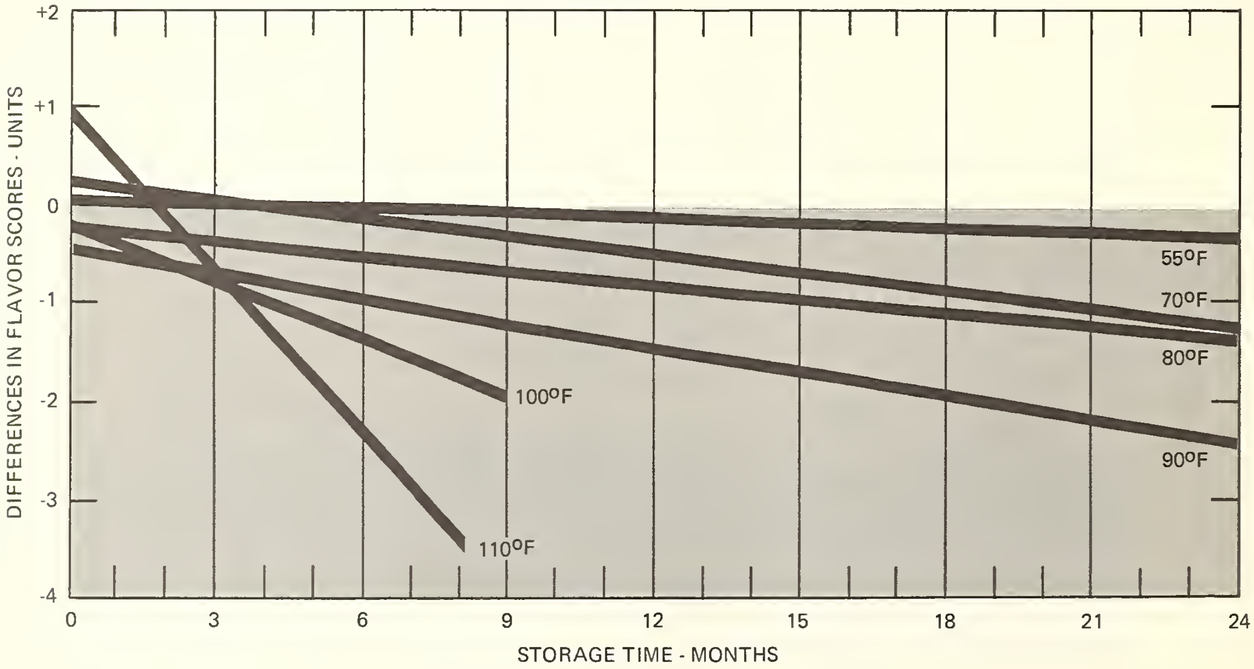

FIGURE 4.—Soybean salad oils from all sources: Average differences in flavor scores between oils stored at six temperatures and oil stored at 0° F.

FLAVOR SCORES AFTER STORAGE PLUS HEAT TREATMENT

Variation in Scoring

It was expected that the controls, after the heat treatment, would vary in flavor scores to about the same extent as they did before the treatment. It was also expected that the heat treatment would lower the flavor scores of the oil. Since the controls were compared with the heat-stored oils more often in this group of observations, a greater number of average scores were available for the overall average scores, as shown in table 3.

Changes After Heat Treatment

When the flavor scores for the control oils after the heat treatment were compared with scores for the same oils before the treatment, the scores were lower for the heat-treated oils. The average score for oil from source 1 had decreased from 8.48 to 7.82, or 0.66 units; for source 2 from 8.51 to 8.24, or 0.27 units; and for source 3 from 8.64 to 8.06, or 0.58 units. As the flavor score decreased for each of the oils, the standard deviation increased, but the rate of increase was not as great as for the oils before the 4-day heat treatment.[5]

Linear correlations were calculated for the data on the heat-treated oils in the same order and manner as on the data for the untreated oils. The differences only are charted in figures 5, 6, and 7. The formulas for the correlations are shown in table 4.

It is evident from the three figures and from the formulas that the 4-day heat treatment changed the flavor of the oils. This was particularly true for oils that had been stored at temperatures of 100° and 110° F. After the oils had received the 4-day heat treatment, their flavor scores no longer decreased with every increase in storage temperature, as did the scores of the oils that were evaluated without the post-storage heat treatment.

The data from all three sources of oils, grouped for each of the six temperatures, are shown in figure 8, and the formulas are tabulated under "all sources" in table 4.

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[5] The formula for all three sources of the oils is: $Y=4.7456-0.4109X$, where $X=$the flavor score and $Y=$the standard deviation, also $r=-0.7309$, $N=51$, and $S_{Y_X}=\pm0.2138$.

TABLE 3.—*Variation in flavor scores of three soybean salad oils stored at 0° F., then heat treated for 4 days at 140° F.*

[Each average and standard deviation was calculated from the flavor scores of the 20 panelists at one sitting of the panel]

Months in Storage	Source 1		Source 2		Source 3	
	Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
6	8. 30	±1. 0438	6. 90	±1. 5526	8. 40	±1. 6026
6	7. 10	±1. 6827	8. 05	±1. 3945	7. 60	±1. 8468
6	7. 70	±1. 3018	7. 20	±1. 9358	8. 60	±1. 1425
6	7. 70	±1. 6890	7. 95	±1. 4318	8. 40	±1. 3139
6	6. 95	±1. 9595	8. 45	±1. 1910	8. 20	±1. 4726
6	7. 55	±1. 6694	8. 15	±1. 4965	8. 35	±1. 2258
12	8. 35	±1. 2258	8. 15	±1. 5985	8. 10	±1. 2937
12	8. 35	±1. 3870	8. 50	±1. 3179	8. 25	±0. 9105
12	8. 70	±1. 0311	9. 20	±1. 0052	7. 40	±1. 7592
12	7. 35	±1. 7852	8. 45	±1. 5720	7. 95	±1. 9324
12	7. 85	±1. 3485	8. 75	±1. 1642	7. 60	±1. 2732
12	6. 80	±1. 1965	9. 20	±1. 0563	7. 60	±2. 1126
18	8. 65	±0. 8127	8. 40	±1. 2312	8. 40	±1. 3917
18	8. 45	±1. 3169	8. 90	±0. 9679	8. 60	±1. 1877
18	7. 80	±1. 2397	8. 25	±1. 8883	7. 95	±1. 1227
24	7. 60	±1. 7889	7. 95	±1. 9050	7. 90	±1. 6190
24	7. 55	±1. 7434	7. 55	±1. 7614	7. 80	±1. 6092
Total	7. 82	±1. 5401	8. 24	±1. 5602	8. 06	±1. 5213

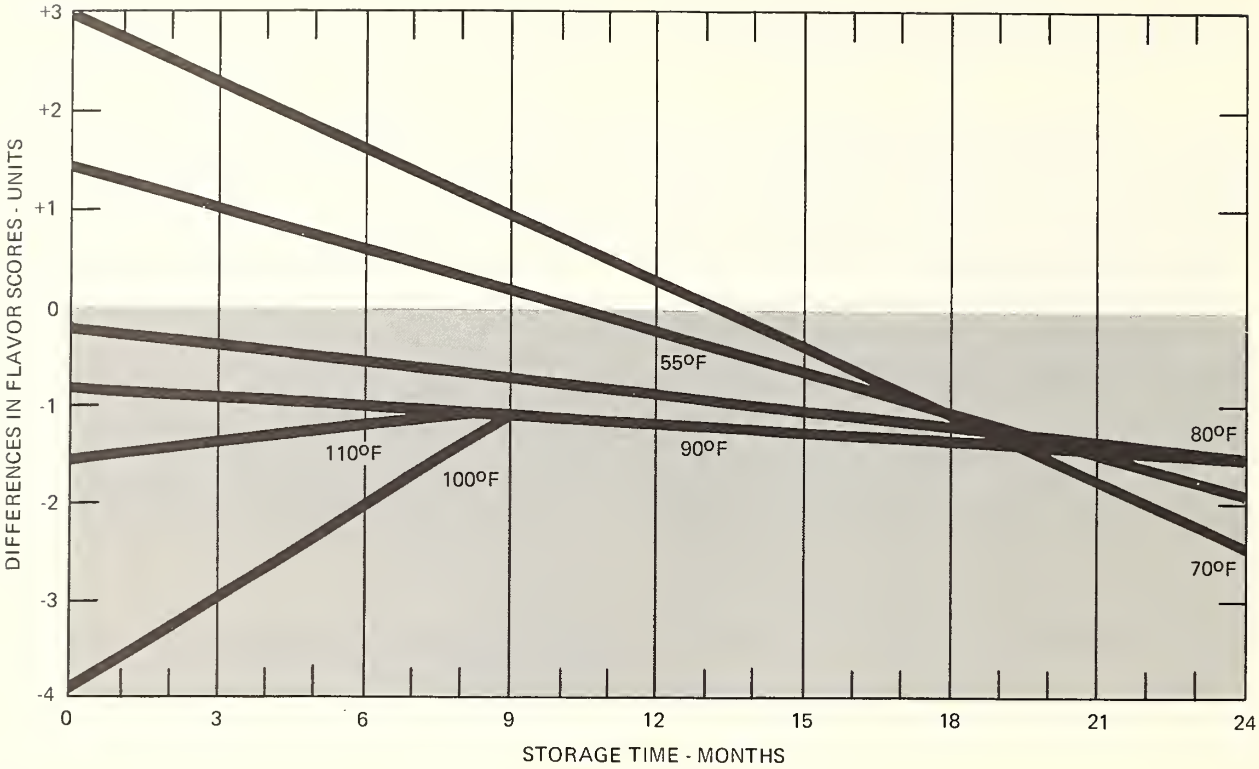

Figure 5.—Soybean salad oil from source 1: Differences in flavor scores between oil stored at six temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

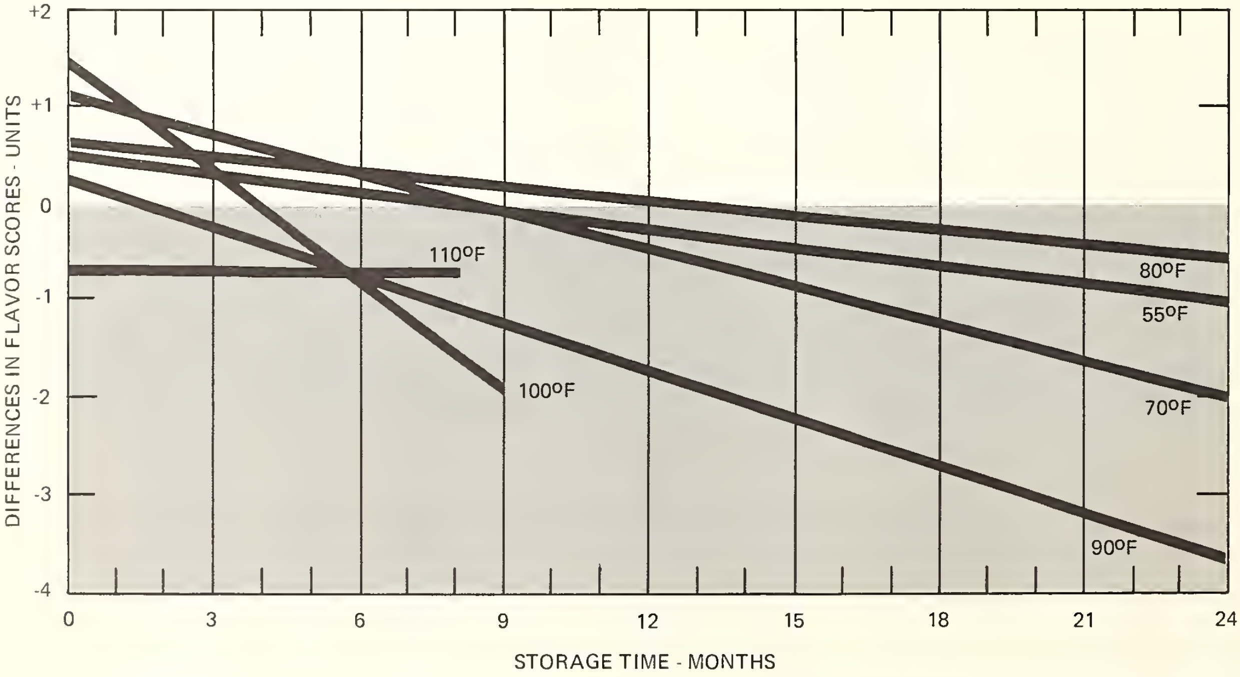

Figure 6.—Soybean salad oil from source 2: Differences in flavor scores between oil stored at six temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

TABLE 4.—*Correlation data for differences of flavor scores of three soybean salad oils after storage at six temperatures from flavor scores of the same oils after storage at 0° F., after a 4-day heat treatment of all oils at 140° F.*

Storage temperature and oil source	Formula	N[1]	r[2]	S_{Y_X}[3]
Oil stored at 55° F.:				
Source 1	Y=+1.4500-0.1372X	80	-0.4867	±1.9679
Source 2	Y=+0.5250-0.0625X	80	-0.2989	±1.3469
Source 3	Y=-0.2750-0.0542X	80	-0.2054	±1.7423
All sources	Y=-0.3306-0.0246X	240	-0.0959	±1.7185
Oil stored at 70° F.:				
Source 1	Y=+3.0000-0.2417X	80	-0.8056	±1.1773
Source 2	Y=+1.1250-0.1250X	80	-0.4382	±1.7312
Source 3	Y=-4.2750+0.2142X	80	+0.8479	±0.8970
All sources	Y=-0.1667-0.0508X	240	-0.1804	±1.8629
Oil stored at 80° F.:				
Source 1	Y=-0.2000-0.0542X	80	-0.2196	±1.6628
Source 2	Y=+0.6500-0.0492X	80	-0.1931	±1.6865
Source 3	Y=-2.6000+0.0825X	80	+0.3289	±1.5990
All sources	Y=-0.7167-0.0069X	240	-0.0263	±1.7688
Oil stored at 90° F.:				
Source 1	Y=-0.7750-0.0304X	60	-0.1132	±2.0106
Source 2	Y=+0.3000-0.1631X	60	-0.4882	±2.2039
Source 3	Y=-1.4500+0.0107X	60	+0.0433	±1.7592
All sources	Y=-0.8875-0.0504X	180	-0.1742	±2.0979
Oil stored at 100° F.:				
Source 1	Y=-3.8583+0.3111X	40	+0.3432	±1.3020
Source 2	Y=+1.4500-0.3667X	40	-0.2920	±1.8777
Source 3	Y=+0.1500-0.1833X	40	-0.1276	±2.0875
All sources	Y=-0.8500-0.0778X	120	-0.0646	±1.8099
Oil stored at 110° F.:				
Source 1	Y=-1.5000+0.0500X	40	+0.0490	±1.5529
Source 2	Y=-0.6667	40	0	±2.2983
Source 3	Y=-6.0333+0.5667X	40	+0.3869	±2.0564
All sources	Y=-3.7333+0.3167X	120	+0.2394	±1.9343

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[1] Number of observations. Oils stored at 55°, 70°, and 80° F. were evaluated after 6, 12, 18, and 24 months. Oils stored at 90° F. were evaluated after 6, 12, and 24 months. Oils stored at 100° F. were evaluated after 6 and 9 months. Oils stored at 110° F. were evaluated after 5 and 8 months.

[2] Correlation coefficient. At the 5-percent confidence limit, $r=0.312$ when $N=40$; $r=0.254$ when $N=60$; $r=0.220$ when $N=80$; and $r=0.170$ when $N=120$. At the 1-percent confidence limit, $r=0.404$ when $N=40$; $r=0.302$ when $N=60$; $r=0.286$ when $N=80$; and $r=0.226$ when $N=120$.

[3] Standard error of estimate.

A comparison of the figures 4 and 8, along with the formulas shown under "all sources" in tables 2 and 4, indicates that the 4-day heat treatment in general appeared to improve the flavor scores of the oils. The decrease in flavor scores of the oils held at 55°, 70°, 80°, and 90° F. was somewhat less at the end of the 2-year storage period. Also, the oils stored at 100° F. at the end of the 9 months of storage had not decreased in flavor score as much as before the 4-day heat treatment, with indications that for even much longer storage, these oils would not show important changes. And, furthermore, the oils stored at 110° F. actually showed improved flavor scores after the 4-day heat treatment at the end of 8 months.

This leads to the conclusion that the flavor of the oils decreased in heated storage in the sealed containers. These off flavors can account for small decreases in flavor score for the oils held below 100° F. and greater decreases in flavor at 100° and 110° F. Apparently the exposure of the oils to air during the 4-day heat treatment at 140° F. volatilized and eliminated these off flavors so that the oils showed more nearly their basic flavor.

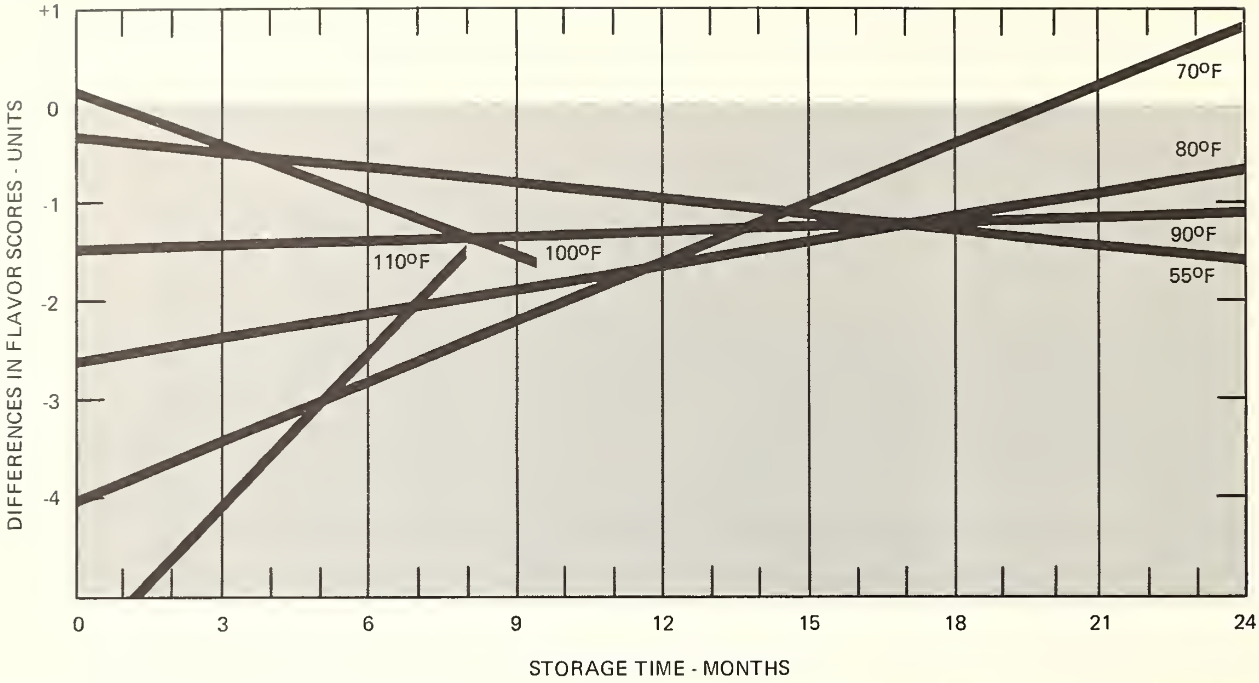

Figure 7.—Soybean salad oil from source 3: Differences in flavor scores between oil stored at six temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

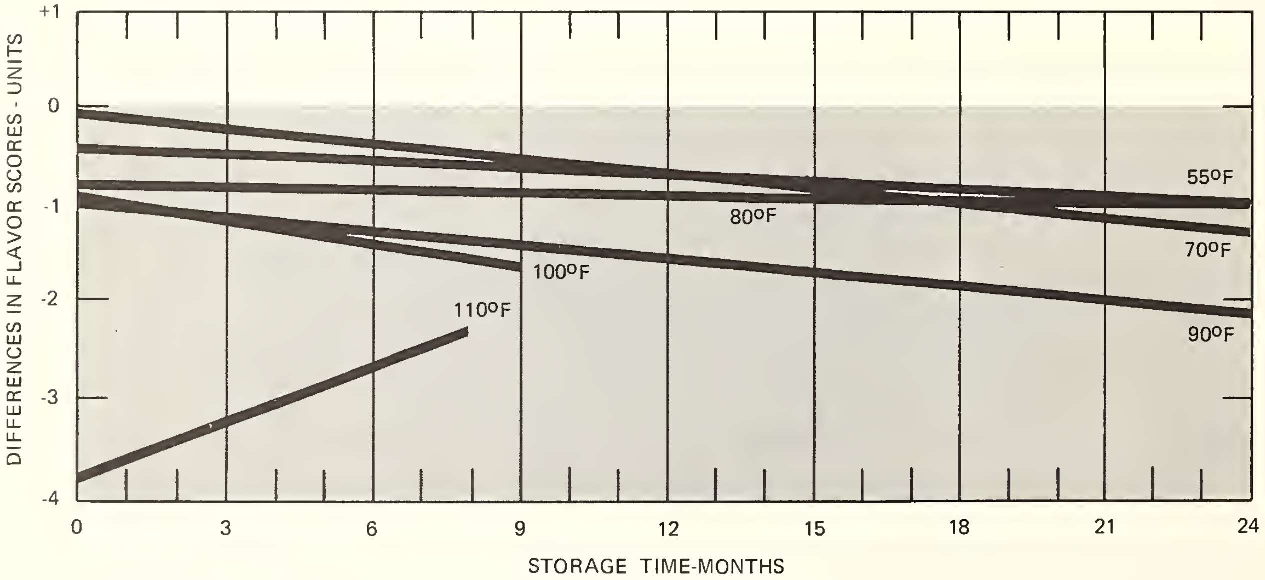

Figure 8.—Soybean salad oils from all sources: Average differences in flavor scores between oils stored at six temperatures and oil stored at 0° F., after 4-day treatment at 140° F.

FLAVOR ADJECTIVES USED

Quality vs. Preference

In standards now used by the edible oil industry, bland salad oils are considered to be of highest quality and are therefore scored highest by well-trained taste panels. Very small differences in flavor are noted.

Even though our housewife panel may have been unable to distinguish very small differences in blandness, they were able to determine their preference for certain oils (which may be of more importance as far as consumer preference is concerned.) It is entirely possible that they were indicating a preference for an oil not quite as bland as the fresh oils.

Scoring by Descriptions

It was expected that any change of flavor score during either or both of the 2-year storage and the further 4-day heat treatment would relate in some measure to the descriptive adjectives used in the panel evaluations. Accordingly, the 12 descriptive terms used at the evaluations, along with numerical scores for comparing flavor of the control with those of the heated oils over the 2-year period, could indicate the nature of the flavors causing these changes. Also, the further heat treatment in the presence of air could cause different flavors of the oils. In this latter treatment, the control was compared with the heated 2-year-stored oils after the control had also been subjected to the same 4-day heat treatment.

Each individual tasting made by each of the panelists on each of the oils was tabulated and totaled for each flavor description and adjusted on a percentage basis. The summary for the evaluations made when the oil was taken from storage *before* the 4-day 140° F. heat treatment is shown in table 5. A summary of the data *after* the 4-day 140° F. heat treatment is shown in table 6.

As shown in table 5 under 0° F., for source 1 oil at 6 months, 68 percent of the panelists described the flavor as bland, 13 percent as buttery, 10 percent as beany, 2 percent as sweet, 5 percent as tallowy, and 2 percent as rancid. Table 6 shows that after the 4-day heat treatment, 28 percent of the panelists judged the same oil bland, 34 percent buttery, 18 percent beany, 1 percent sweet, 1 percent bitter, 4 percent grassy, 5 percent painty, 3 percent musty, 2 percent metallic, 1 percent tallowy, and 4 percent rancid.

The differences between the flavor descriptions of the oils from refrigerated storage and the descriptions of the oils from heated storage can be calculated from data in tables 5 and 6 by taking the numerical differences between the percentages of panelists that used a given term for the two different oils at the end of a given period of storage.

Changes After Storage and After Heat Treatment

Tables 5 and 6 show 57 observations for each of these differences in flavor descriptions before and after the 4-day heat treatment. Linear correlations were made relating these data to the periods of time in storage. These formulas are given in table 7 and shown graphically in figures 9, 10, and 11. As the descriptions "sweet," "sour," and "bitter" were seldom used by the panel, no calculations were made from these data.

Considerable variation in use of the flavor descriptions by the panel was expected, even more than in the numerical flavor scores. This variation is shown in table 7 by the standard errors of estimate (S_{YX}). Had the correlations been perfect, all of the regression lines shown would have been zero at 0 months. With the exception of "bland," "beany," and "buttery" before treatment and "rancid" after treatment, the regressions do start close to zero at 0 months.

The results shown in table 7 and figures 9, 10, and 11 indicate the 4-day heat treatment of the stored oils resulted in minor changes in the flavor descriptions. However, there seemed to be little relationship between the changes in flavor scores and the flavor descriptions used by the panel.

Nothing was done before the evaluations were made to define or interpret for panel members the meaning of the flavor descriptions used in the study. Accordingly, a panel more experienced in judging soybean salad oils could have used the flavor descriptions differently and probably more in keeping with natural flavors of soybean oil.

However, it can be concluded that off flavors did develop during the unrefrigerated storage of the oils in sealed containers and that the 4-day heat treatment did remove part of these off flavors.

TABLE 5.—*Percent of panelists applying given adjectives to three soybean salad oils stored in 1-gallon sealed cans at seven temperatures for specified times and evaluated immediately after removal from storage*

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
Oil stored 6 mo. at:												
0° F.:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Source 1	68	13	10	2	0	0	0	0	0	0	5	2
Source 2	49	28	11	0	0	0	0	0	0	5	5	2
Source 3	66	24	5	2	0	0	0	0	0	1	0	2
All sources	61	22	9	1	0	0	0	0	0	2	3	2
55° F.:												
Source 1	44	48	0	8	0	0	0	0	0	0	0	0
Source 2	32	32	23	0	0	0	0	3	0	6	4	0
Source 3	45	39	16	0	0	0	0	0	0	0	0	0
All sources	40	40	13	3	0	0	0	1	0	2	1	0
70° F.:												
Source 1	39	28	17	3	0	0	3	0	0	0	10	0
Source 2	62	17	17	4	0	0	0	0	0	0	0	0
Source 3	27	45	15	0	4	0	0	0	0	0	3	6
All sources	43	30	16	2	1	0	1	1	1	0	4	3
80° F.:												
Source 1	25	42	14	0	0	0	4	4	4	0	3	4
Source 2	69	21	10	0	0	0	0	0	0	0	0	0
Source 3	36	30	24	0	0	0	0	0	6	0	0	4
All sources	43	31	16	0	0	0	1	0	0	0	4	4
90° F.:												
Source 1	14	25	31	0	0	0	0	3	0	14	10	3
Source 2	22	28	28	0	0	0	9	0	0	0	10	3
Source 3	11	14	14	8	0	0	14	14	3	3	11	8
All sources	16	22	24	3	0	0	8	6	1	6	10	5
100° F.:												
Source 1	17	38	14	0	0	0	7	7	0	0	17	0
Source 2	12	9	18	0	0	3	9	12	3	0	16	18
Source 3	19	23	29	0	0	0	6	13	0	7	0	3
All sources	16	23	20	0	0	1	7	11	1	2	11	7
110° F.:[1]												
Source 1	21	18	9	0	0	0	6	18	3	0	22	3
Source 2	33	27	20	0	0	3	0	3	0	7	4	3
Source 3	5	28	12	0	0	2	16	9	2	14	3	9
All sources	20	24	14	0	0	1	7	10	2	7	10	5
Oil stored 12 mo. at:												
0° F.:												
Source 1	50	22	9	0	0	2	2	0	3	5	4	3
Source 2	37	25	9	1	1	0	0	12	4	1	6	0
Source 3	50	24	13	0	0	0	5	2	0	3	1	0
All sources	46	24	10	0	0	1	2	5	2	3	4	1

55° F.:												
Source 1	39	36	3	3	0	0	0	0	0	9	10	0
Source 2	45	39	9	0	0	0	0	0	0	0	0	4
Source 3	35	39	19	0	0	0	0	0	0	0	7	0
All sources	40	38	10	1	0	0	0	1	0	3	6	1
70° F.:												
Source 1	16	58	10	10	0	0	0	3	3	0	0	0
Source 2	44	50	3	0	0	0	0	0	0	0	0	3
Source 3	15	33	45	0	0	0	0	0	4	0	0	3
All sources	25	47	19	3	0	0	4	0	2	0	0	2
80° F.:												
Source 1	23	32	19	0	0	0	13	0	10	0	3	0
Source 2	30	32	21	0	0	0	0	0	0	17	0	0
Source 3	19	22	34	0	0	0	0	0	9	0	10	6
All sources	24	29	25	0	1	2	0	0	6	6	4	2
90° F.:												
Source 1	23	37	11	6	0	3	0	6	6	0	5	3
Source 2	21	46	11	0	3	4	0	4	0	4	0	7
Source 3	17	40	17	0	0	0	0	0	8	0	18	0
All sources	20	41	13	2	0	0	0	3	5	1	8	3
100° F.: [2]												
Source 1	23	19	32	0	0	0	0	6	0	3	11	6
Source 2	30	22	19	3	0	4	0	4	4	7	0	7
Source 3	11	2	21	0	0	2	6	11	2	19	11	15
All sources	21	14	24	1	0	2	2	7	2	10	7	9
110° F.: [3]												
Source 1	5	2	21	0	0	5	2	12	14	2	4	33
Source 2	5	17	20	0	0	7	0	5	5	0	26	15
Source 3	7	12	14	0	0	12	5	7	5	26	5	7
All sources	6	10	18	0	0	8	2	8	8	9	12	18
Oil stored 18 mo. at:												
0° F.:												
Source 1	68	12	12	0	0	0	4	0	0	0	4	0
Source 2	40	37	10	0	0	0	0	0	0	7	3	3
Source 3	56	28	12	4	0	0	0	0	0	0	0	0
All sources	55	26	11	1	0	0	1	0	0	2	2	1
55° F.:												
Source 1	79	11	6	0	0	4	0	0	0	0	0	0
Source 2	33	59	8	0	0	0	0	0	0	0	0	0
Source 3	19	22	22	22	0	0	6	0	0	6	3	0
All sources	44	31	12	7	0	1	2	0	0	2	1	0
70° F.:												
Source 1	40	30	27	0	0	0	0	0	0	0	0	3
Source 2	37	53	10	0	0	0	0	0	0	0	0	0
Source 3	21	30	12	6	0	0	0	0	6	0	7	18
All sources	33	38	16	2	0	0	0	0	2	0	2	7

See footnotes at end of table.

TABLE 5.—*Percent of panelists applying given adjectives to three soybean salad oils stored in 1-gallon sealed cans at seven temperatures for specified times and evaluated immediately after removal from storage*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
Oil stored 18 mo. at:												
80° F.:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Source 1	29	26	19	6	0	0	3	0	0	14	0	3
Source 2	50	37	7	0	0	0	3	0	0	0	0	3
Source 3	17	14	9	0	2	6	9	3	20	0	0	20
All sources	32	26	12	2	1	2	5	1	7	5	0	9
Oil stored 24 mo. at:												
0° F.:												
Source 1	54	34	2	6	2	0	0	0	2	0	0	0
Source 2	66	26	2	5	0	0	0	0	0	0	1	0
Source 3	65	27	0	8	0	0	0	3	0	0	0	0
All sources	62	29	1	6	1	0	0	1	1	1	0	0
55° F.:												
Source 1	33	57	10	0	0	0	0	0	0	0	0	0
Source 2	36	32	14	4	0	0	0	0	0	0	14	0
Source 3	32	35	3	3	0	0	0	0	0	15	9	0
All sources	34	41	9	2	0	0	0	0	0	5	8	0
70° F.:												
Source 1	9	44	3	0	0	3	9	15	0	0	5	12
Source 2	21	36	14	0	0	0	7	0	0	4	7	11
Source 3	9	29	15	6	0	0	9	0	0	6	8	18
All sources	13	36	11	2	0	1	8	5	0	3	7	10
80° F.:												
Source 1	13	42	10	0	0	0	6	0	9	6	4	10
Source 2	18	32	25	0	0	0	0	4	7	0	14	0
Source 3	31	52	3	0	0	4	0	0	7	0	0	3
All sources	21	42	13	0	0	1	2	1	8	1	6	4
90° F.:												
Source 1	24	26	13	3	0	0	13	5	3	0	13	0
Source 2	11	40	14	0	0	10	0	11	0	0	3	11
Source 3	6	10	26	0	0	0	3	19	0	6	4	26
All sources	14	25	18	1	0	3	5	12	1	2	7	12

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[1] Oil sampled at 5 months instead of 6. [2] Oil sampled at 9 months instead of 12. [3] Oil sampled at 8 months instead of 12.

Table 6.—*Percent of panelists applying given adjectives to three soybean salad oils stored in 1-gallon sealed cans at seven temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
Oil stored 6 mo. at:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0° F.:												
Source 1	28	34	18	1	0	1	4	5	3	2	1	4
Source 2	30	34	17	0	0	0	5	2	0	5	4	3
Source 3	40	38	11	0	0	0	3	0	1	3	0	4
All sources	33	35	15	0	0	0	4	2	1	3	2	4
55° F.:												
Source 1	12	27	21	4	1	0	5	7	0	8	13	5
Source 2	22	35	14	1	2	0	4	6	0	2	7	5
Source 3	20	33	22	0	0	0	5	2	1	6	5	6
All sources	18	32	19	2	1	0	5	5	0	5	8	5
70° F.:												
Source 1	32	35	14	1	0	0	0	9	1	2	6	0
Source 2	40	30	18	1	0	0	3	3	0	1	0	4
Source 3	19	33	17	0	1	1	3	6	0	6	5	9
All sources	30	33	16	1	0	0	2	6	0	3	4	4
80° F.:												
Source 1	11	22	19	1	0	0	5	20	5	9	5	5
Source 2	24	36	26	1	0	0	3	1	0	3	5	1
Source 3	21	45	16	3	0	1	3	1	1	6	2	1
All sources	19	34	20	2	0	0	4	7	2	6	4	2
90° F.:												
Source 1	18	37	21	0	0	0	3	5	7	1	6	3
Source 2	28	38	18	1	0	0	1	3	0	6	2	2
Source 3	18	46	19	1	0	0	1	2	1	2	3	8
All sources	21	40	19	1	0	0	2	3	2	3	4	4
100° F.:												
Source 1	25	22	19	0	1	1	2	15	1	5	5	2
Source 2	26	29	9	0	1	0	1	5	0	6	5	16
Source 3	27	37	16	0	1	0	1	2	2	2	2	6
All sources	26	29	15	0	1	0	1	7	1	4	4	8
110° F.:[1]												
Source 1	18	40	16	0	1	0	1	4	3	5	8	1
Source 2	29	31	15	0	0	0	3	3	0	4	5	12
Source 3	9	23	10	0	0	0	12	5	3	5	8	28
All sources	19	31	14	0	0	0	5	4	2	5	7	14

See footnotes at end of table.

TABLE 6.—*Percent of panelists applying given adjectives to three soybean salad oils stored in 1-gallon sealed cans at seven temperatures for specified times and evaluated after removal from storage and treatment for 4 days at 140° F.*—Continued

Storage time, temperature, and source of oil	Panelists using adjective to describe flavor of oil											
	Bland	Buttery	Beany	Sweet	Sour	Bitter	Grassy	Painty	Musty	Metallic	Tallowy	Rancid
Oil stored 12 mo. at:												
0° F.:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Source 1	32	30	21	0	0	1	6	0	2	1	6	1
Source 2	48	31	12	2	1	0	2	1	0	1	0	2
Source 3	39	32	14	1	0	2	3	2	0	1	4	2
All sources	40	31	16	1	0	1	4	1	1	1	3	2
55° F.:												
Source 1	45	35	6	2	0	2	4	1	0	3	1	1
Source 2	46	25	16	2	0	2	3	0	0	0	6	0
Source 3	41	31	16	2	0	3	1	0	0	0	3	3
All sources	44	30	13	2	0	2	3	0	0	1	3	1
70° F.:												
Source 1	38	25	13	0	0	5	3	2	1	2	5	6
Source 2	49	28	8	2	0	0	2	1	3	3	3	1
Source 3	15	33	28	0	0	3	2	3	2	3	8	3
All sources	34	29	16	1	0	3	2	2	2	3	5	3
80° F.:												
Source 1	27	29	21	0	0	0	1	4	0	1	6	11
Source 2	28	41	23	0	1	0	1	0	1	1	0	4
Source 3	10	15	11	0	0	5	3	10	12	13	8	13
All sources	22	28	18	1	0	2	2	5	4	5	5	9
90° F.:												
Source 1	27	23	22	2	0	0	8	1	5	2	5	5
Source 2	20	28	19	0	0	4	1	10	1	5	7	5
Source 3	26	26	16	0	1	0	0	5	6	7	5	8
All sources	24	26	19	1	0	1	3	5	4	5	6	6
100° F.:[2]												
Source 1	8	21	15	0	0	0	10	12	10	4	5	15
Source 2	26	31	20	2	0	1	0	4	1	2	9	4
Source 3	20	18	11	0	0	3	2	8	11	5	5	17
All sources	18	23	15	1	0	1	4	8	7	4	6	12
110° F.:[3]												
Source 1	11	5	21	0	2	1	8	15	2	7	8	20
Source 2	18	16	17	0	0	4	4	2	7	4	14	14
Source 3	16	27	17	3	1	3	7	5	5	6	6	4
All sources	15	16	18	1	1	3	6	11	5	6	9	13

Oil stored 18 mo. at:												
0° F.:												
Source 1	42	38	11	1	0	0	0	3	0	0	5	0
Source 2	59	25	5	1	0	0	0	1	0	1	7	1
Source 3	48	36	6	0	0	0	0	0	0	1	9	0
All sources	50	33	7	1	0	0	0	1	0	1	7	0
55° F.:												
Source 1	50	29	8	2	0	0	0	1	2	0	7	2
Source 2	39	44	4	4	0	0	0	2	1	0	6	0
Source 3	41	34	12	3	0	1	0	1	2	2	3	1
All sources	43	36	8	3	0	0	0	1	2	1	5	1
70° F.:												
Source 1	26	42	10	0	0	0	0	3	3	1	11	4
Source 2	26	35	10	3	0	0	1	2	0	4	14	5
Source 3	22	47	9	5	0	0	2	1	3	2	7	1
All sources	25	41	10	3	0	0	1	2	2	2	11	3
80° F.:												
Source 1	19	34	15	1	0	0	5	9	2	3	9	3
Source 2	33	31	14	3	0	0	1	8	0	4	5	1
Source 3	20	49	7	4	0	2	0	3	0	2	10	3
All sources	24	38	12	3	0	1	2	7	1	3	8	2
Oil stored 24 mo. at:												
0° F.:												
Source 1	25	43	7	0	3	0	3	3	5	0	6	5
Source 2	20	53	8	0	0	2	5	0	2	0	0	10
Source 3	32	30	9	2	0	0	4	4	4	4	7	4
All sources	26	42	8	1	1	1	4	2	4	1	4	6
55° F.:												
Source 1	26	41	0	4	0	0	0	7	4	4	10	4
Source 2	23	43	20	3	0	0	0	0	7	0	4	0
Source 3	19	15	4	0	0	4	11	4	11	11	14	7
All sources	23	33	8	2	0	1	4	4	7	5	9	4
70° F.:												
Source 1	3	13	3	0	0	0	0	30	3	13	12	23
Source 2	9	21	3	0	0	0	0	3	15	18	10	21
Source 3	13	37	13	0	0	0	0	7	7	3	10	10
All sources	8	24	6	0	0	0	0	13	12	8	11	18
80° F.:												
Source 1	10	51	6	3	0	3	0	3	6	3	9	6
Source 2	11	50	7	4	0	0	0	4	0	0	20	4
Source 3	23	19	12	0	0	4	0	12	12	0	3	15
All sources	15	40	8	2	0	2	0	10	6	1	11	8
90° F.:												
Source 1	7	7	15	7	0	4	7	26	4	7	9	7
Source 2	0	13	0	5	0	8	0	2	5	5	30	42
Source 3	15	18	9	3	0	3	9	18	9	3	3	9
All sources	12	13	8	5	0	5	5	15	6	5	14	19

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[1] Oil sampled at 5 months instead of 6. [2] Oil sampled at 9 months instead of 12. [3] Oil sampled at 8 months instead of 12.

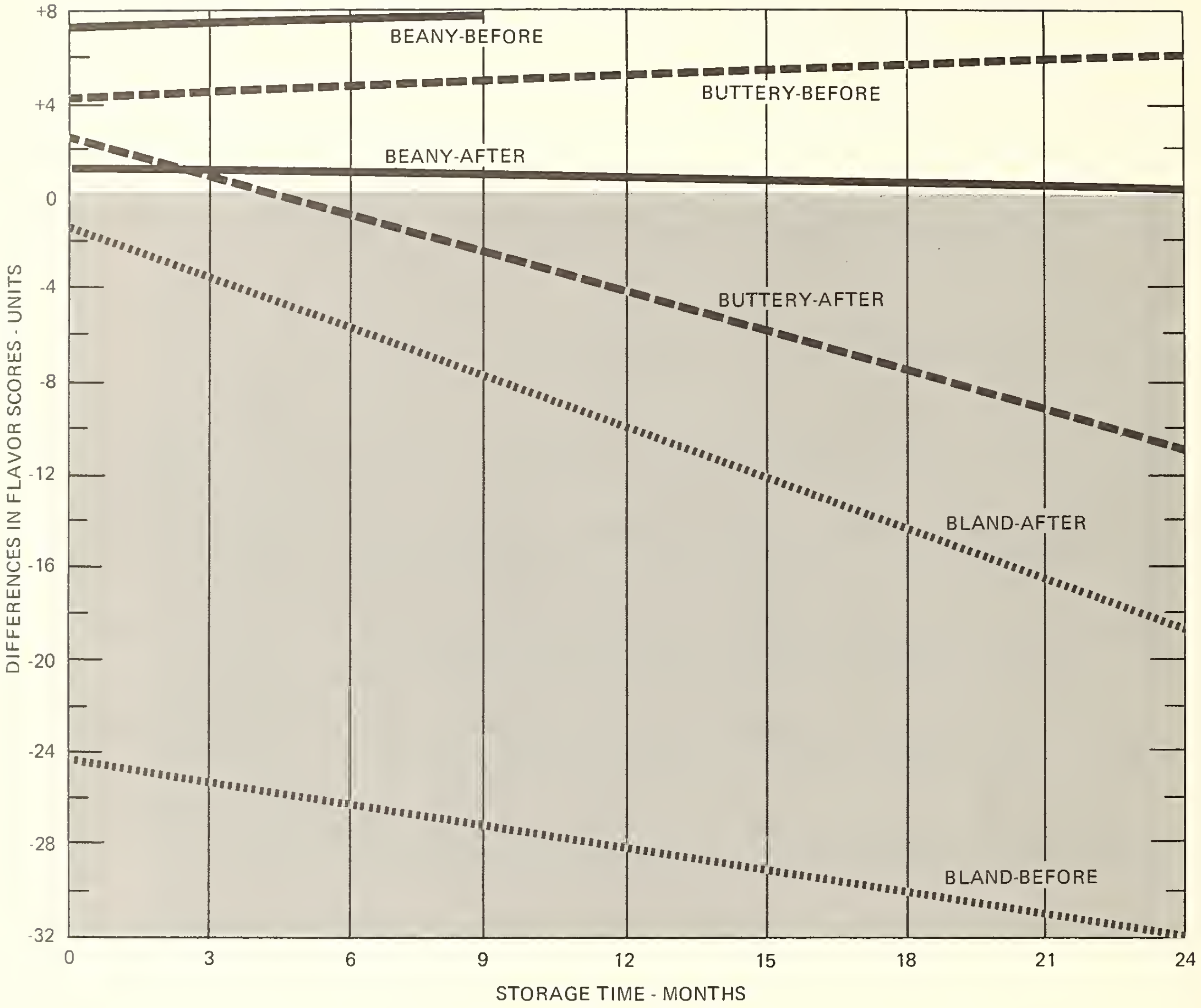

FIGURE 9.—Difference between incidence of bland, buttery, and beany flavors in soybean salad oils stored at six temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

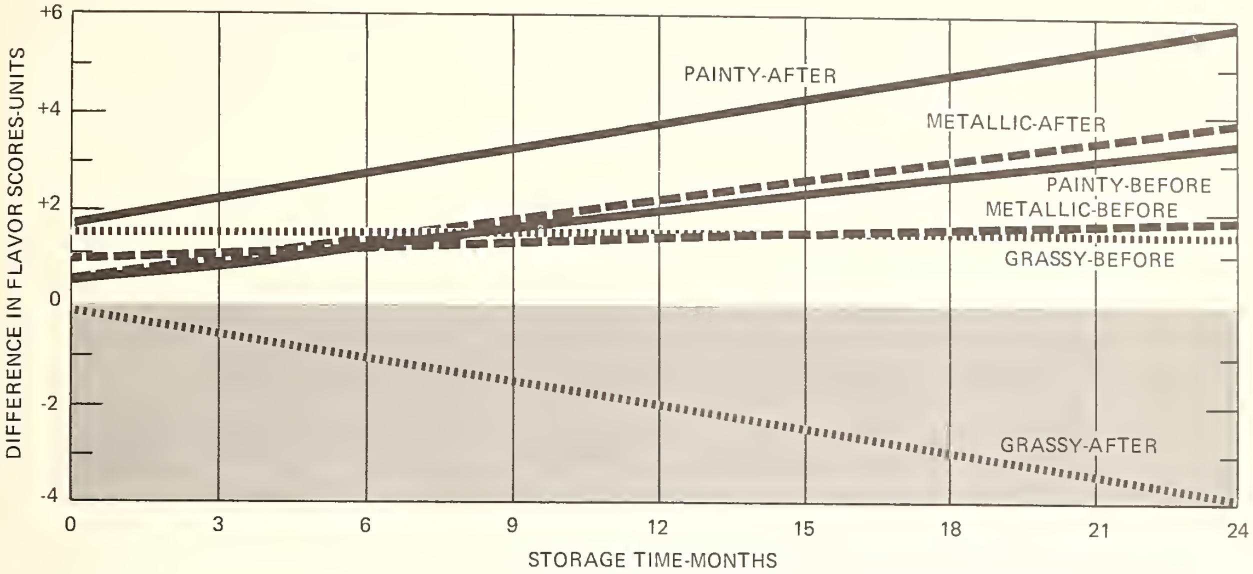

FIGURE 10.—Difference between incidence of grassy, painty, and metallic flavors in soybean salad oils stored at six temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

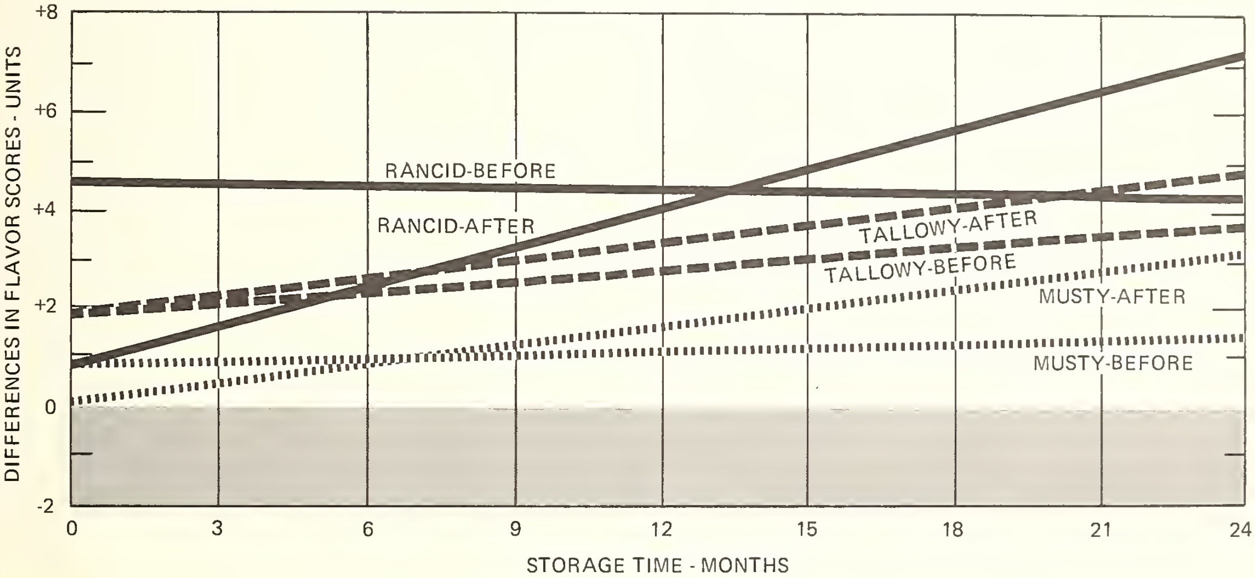

FIGURE 11.—Difference between incidence of musty, rancid, and tallowy flavors in soybean salad oils stored at six temperatures and incidence of same flavors in oils stored at 0° F., calculated before and after 4-day heat treatment at 140° F.

TABLE 7. *Correlation data for differences between percent of panelists applying given adjectives to three soybean salad oils after storage at 0° F. and percent of same panelists applying same adjectives to same oils after storage at six different temperatures, calculated before and after 4-day heat treatment of oils at 140° F.*

Flavor descriptive adjective [1] and heat treatment	Formula	N [2]	r [3]	S_{YX} [4]
Bland:				
Before heat treatment	$Y=-24.3265-0.3299X$	57	−0.1175	±20.0343
After heat treatment	$Y=-1.3828-0.7096X$	57	−0.3603	±13.2045
Buttery:				
Before heat treatment	$Y=+4.1661+0.0807X$	57	+0.0377	±15.3710
After heat treatment	$Y=+2.4791-0.5551X$	57	−0.3353	±11.2105
Beany:				
Before heat treatment	$Y=+7.4929+0.0559X$	57	+0.0438	±9.8576
After heat treatment	$Y=+1.9864-0.0696X$	57	−0.0857	±5.8187
Grassy:				
Before heat treatment	$Y=+1.5088$	57	0	±5.1400
After heat treatment	$Y=-0.1949-0.0092X$	57	−0.0221	±2.9845
Painty:				
Before heat treatment	$Y=+0.5862+0.1155X$	57	+0.1214	±6.7836
After heat treatment	$Y=+1.7534+0.1667X$	57	+0.2028	±5.7850
Metallic:				
Before heat treatment	$Y=+1.0808+0.0299X$	57	+0.0323	±6.6500
After heat treatment	$Y=+0.6176+0.1371X$	57	+0.2532	±3.7629
Musty:				
Before heat treatment	$Y=+0.8706+0.0578X$	57	+0.0969	±4.2695
After heat treatment	$Y=+0.1606+0.1238X$	57	+0.2505	±3.4382
Rancid:				
Before heat treatment	$Y=+0.9284+0.2548X$	57	+0.2367	±7.5158
After heat treatment	$Y=+4.6228-0.0167X$	57	−0.0153	±7.8307
Tallowy:				
Before heat treatment	$Y=+1.8827+0.0742X$	57	+0.0782	±6.8070
After heat treatment	$Y=+1.9042+0.1179X$	57	+0.1406	±5.9686

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[1] The flavor descriptive adjectives "sweet", "sour", and "bitter" were so seldom used that they are not considered here.

[2] Number of observations.

[3] Correlation coefficient. When $N = 57$, then $r = +0.254$ at the 5-percent confidence limit, and $r = 0.332$ at the 1-percent confidence limit.

[4] Standard error of estimate.

APPENDIX

Report 1

O-Time Flavor Panel Evaluation

Series_______________ Source of Oil_______________

NAME OF PANELIST_______________ Date_______________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odor.

*Code No.									
		Sample 1		Sample 2		Sample 3		Sample 4	
		O	F	O	F	O	F	O	F
Very Good	10								
Good	9								
	8								
Fair	7								
	6								
Poor	5								
	4								
Bad	3								
	2								
Very Bad	1								

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong

	Sample 1	Sample 2	Sample 3	Sample 4
Bland				
Buttery				
Beany				
Grassy				
Rancid				
Painty				
Metallic				
Musty				
Bitter				
Sour				
Sweet				
Tallowy				

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

Report 2

MQRD-ARS-USDA 2-106

4 Days at 60°C. Flavor Panel Evaluation

Series__________ Source of Oil____________

NAME OF PANELIST________________________ DATE_____________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F). Determine which oil has the less odor first. Taste this oil for flavor first.

*CODE NO.					
		SAMPLE 1		SAMPLE 2	
		O	F	O	F
Very Good	10				
Good	9				
	8				
Fair	7				
	6				
Poor	5				
	4				
Bad	3				
	2				
Very Bad	1				

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong.

	SAMPLE 1	SAMPLE 2
Bland		
Buttery		
Beany		
Grassy		
Rancid		
Painty		
Metallic		
Musty		
Bitter		
Sour		
Sweet		
Tallowy		

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

Report 3

O-Time Flavor Panel Evaluation

Series________________ Source of Oil______________

NAME OF PANELIST______________________ Date________________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odors.

*Code No.							
		Sample 1		Sample 2		Sample 3	
		O	F	O	F	O	F
Very Good	10						
Good	9						
	8						
Fair	7						
	6						
Poor	5						
	4						
Bad	3						
	2						
Very Bad	1						

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong

	Sample 1	Sample 2	Sample 3
Bland			
Buttery			
Beany			
Grassy			
Rancid			
Painty			
Metallic			
Musty			
Bitter			
Sour			
Sweet			
Tallowy			

*Code No. to be filled in by Panel Supervisor after evaluation by panelist .

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Report 4

4-Day Flavor Panel Evaluation

Series ____________ Source of Oil __________

NAME OF PANELIST __________________________ DATE ___________

Please indicate the score by placing a check mark (✓) in the space opposite the proper intensity for odor (O) and flavor (F).

Determine intensity of odors first. Then taste for flavor beginning with oil of least odor followed by other oils of increasing intensity of odors.

*Code No.							
		SAMPLE 1		SAMPLE 2		SAMPLE 3	
		O	F	O	F	O	F
Very Good	10						
Good	9						
	8						
Fair	7						
	6						
Poor	5						
	4						
Bad	3						
	2						
Very Bad	1						

Please indicate intensities of flavors by placing check marks opposite the proper flavor. (✓) Weak; (✓✓) Moderate; (✓✓✓) Strong.

	SAMPLE 1	SAMPLE 2	SAMPLE 3
Bland			
Buttery			
Beany			
Grassy			
Rancid			
Painty			
Metallic			
Musty			
Bitter			
Sour			
Sweet			
Tallowy			

*Code No. to be filled in by Panel Supervisor after evaluation by panelist.

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